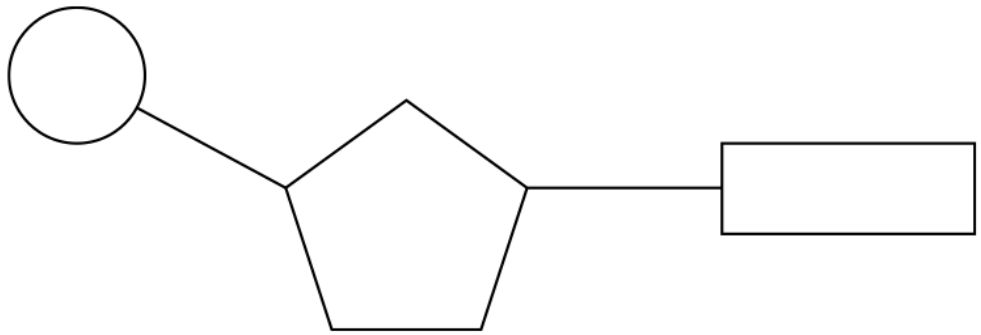
1.

The diagram below shows a simple nucleotide.



(a) On the diagram above, draw a circle around the component that contains nitrogen. [1]

(b) Describe **two** differences between a DNA nucleotide and an RNA nucleotide. [2]

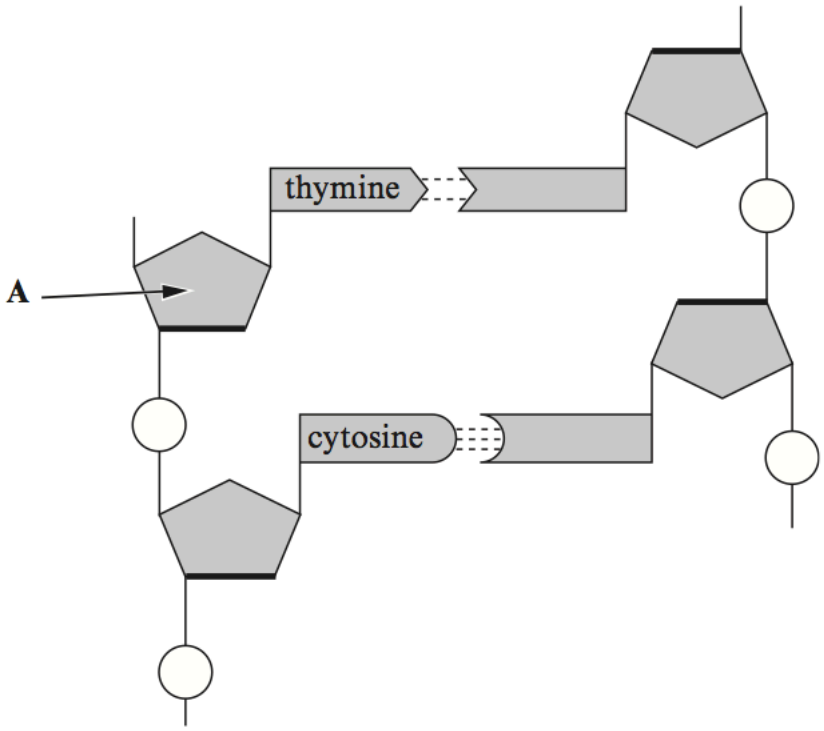
An experiment was carried out to determine the relative percentages of the bases in DNA from various organisms. The results are shown in the table below.

Source of DNA	**Relative percentage of base in sample**			
	Adenine	Guanine	Thymine	Cytosine
human	30.9	19.9	29.4	19.8
sea urchin	32.8	17.7	32.1	17.3
wheat	27.3	22.7	27.1	22.8

(c) DNA is a double stranded molecule. Explain how the data in the table supports the concept of complementary base pairing. [2]

2.

The diagram represents the molecular structure of part of a DNA molecule.



(a) Name part **A**. [1]

.....

(b) Part of a DNA molecule has the following sequence of bases.

T-A-T-C-G

(i) In the table below write the letters for the sequence of bases of the complementary portion of DNA. [1]

DNA molecule	T	A	T	C	G
complementary DNA					

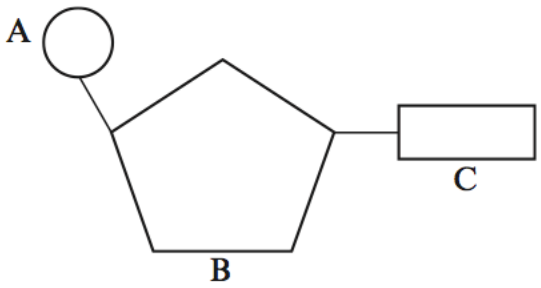
(ii) Biochemical analysis of a sample of DNA showed that 30% of the bases were guanine.
Calculate the percentage of the bases in the sample which would be adenine.
Show your working. [2]

Answer .....

(Total 4 marks)

3.

(a) The diagram below shows a unit which makes up nucleic acids.



(i) Name the structural unit shown. [1]

.....

(ii) Name component **A**. [1]

.....

(iii) Name component **B** in DNA and RNA. [1]

DNA .....

RNA .....

(iv) Name the **four** components found in DNA, represented by **C**. [2]

.....

.....

(b) Describe how the structural units, drawn in part *(a)*, are arranged in DNA molecules. [4]

.....

.....

.....

.....

.....

.....

(c) Describe the function of DNA molecules in cells. [1]

.....

.....

(Total 10 marks)

4.

(a) Complete the table below which compares DNA with messenger RNA (mRNA). [4]

Feature	*DNA*	*mRNA*
Name of sugar		
Number of carbon atoms in sugar		
Number of polynucleotide chains in molecule		
Location in cell		

(b) The table below shows the relative amounts of the four bases in DNA taken from three sources.

	Nitrogenous base (relative amounts)			
Cellular source of DNA	*Adenine*	*Guanine*	*Cytosine*	*Thymine*
rat muscle	28·6	21·4	21·5	28·4
wheat seed	27·3	22·7	22·9	27·1
yeast	31·3	18·7	17·1	32·9

(i) Explain why the relative amount of adenine is almost the same as the relative amount of thymine in **each** source. [3]

.....

.....

.....

(ii) Explain why the base sequence of the DNA samples taken from a rat's bone marrow would be the same as those taken from the muscle of the **same** rat. [3]

.....

.....

.....

.....

(iii) Explain how a sample of DNA from a rat sperm cell differs from that of a muscle cell from the **same** rat. [3]

.....

.....

.....

.....

(Total 13 marks)

5.

Two types of nucleic acid, DNA and RNA are found in cells. Statements in the table, may apply to DNA, RNA or both. Complete the table by putting a tick (✓) if the statement is true or a cross (✗) if the statement is not true. [6]

	DNA	*RNA*
Contains a pentose sugar		
Found in the nucleus		
Thymine is never present		
Consists of a double helix		
Molecules short lived		
Associated with ribosomes		

(Total 6 marks)

6.

(a) (i) Draw a simple **labelled** diagram to show how the three parts of a nucleotide are arranged. [3]

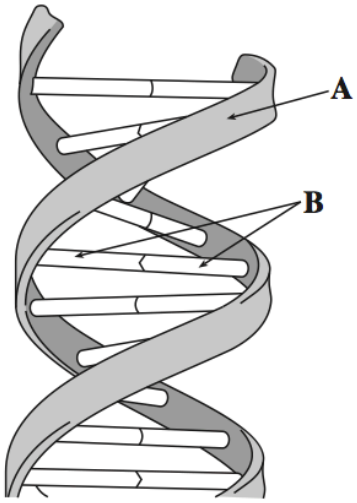
(ii) How do nucleotides of RNA differ from nucleotides of DNA? [2]

.....

.....

.....

(b) The DNA molecule is a double helix. It may be described as a coiled ladder.



(i) What are the 'uprights' of the ladder, labelled **A**, made of? [1]

.....

(ii) The 'rungs' are made by the pairing of components labelled **B**.
Name the components in their complementary pairs. [2]

.....

.....

(iii) Name the type of bonds that hold the pairs together. [1]

.....

(Total 9 marks)

01)

7.

5. *(a)* In the table below, give **three** differences between the structures of DNA and RNA. [3]

	DNA	RNA
1.	....	....
2.	....	....
3.	....	....

8.

Until recently it was believed that there were three different types of RNA found within cells. Ten years ago a fourth type of RNA was discovered in the cytoplasm, small interfering RNA or guide RNA.
These RNA molecules are between 20-25 nucleotides long and they are double stranded.
There is considerable excitement about this in the scientific world as this type of RNA interferes with protein synthesis and synthetic small interfering RNA molecules could in the future be used to treat viral diseases such as HIV and hepatitis.

(a) (i) Complete the following list of the types of RNA found within cells. [2]
Messenger RNA.
Small interfering RNA (guide RNA)

.....

.....

(ii) Give **one** *similarity* and **three** *differences* between small interfering RNA and DNA. [4]

Similarity .....

Differences

1 .....

.....

2 .....

.....

3 .....

.....

(b) (i) If a sample of **DNA** contains 50% purine bases what would be the percentage of pyrimidine bases in the sample? [1]

.....

(ii) Of the 50% purine bases, 10% was Adenine. Complete the table showing the percentage of the other nucleotides. [3]

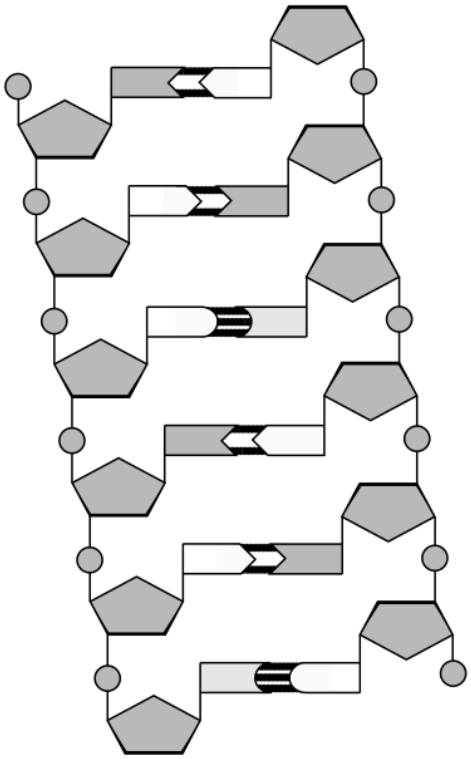
Nucleotide	*Percentage (%)*
Adenine	10

(01) **(Total 10 marks)**

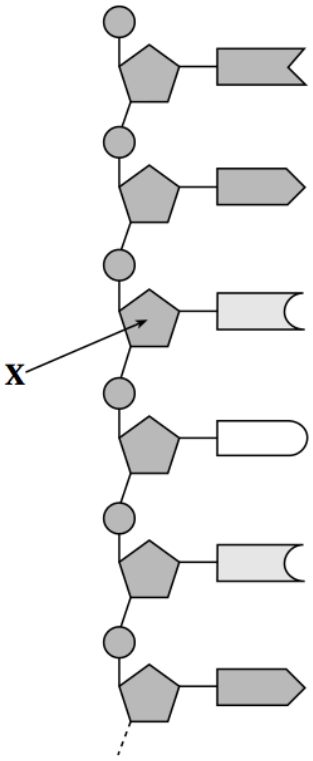
9.

The diagrams below represent two biological molecules.

A



B



(a) (i) Name molecules **A** and **B**. [1]

A .....

B .....

(ii) Name **X**. [1]

.....

(iii) Where in the cell would you find molecule **A**? [1]

.....

(iv) Name the bond that holds the two strands together in **A**. [1]

.....

(v) Give **one other** structural difference, not illustrated in the diagram, between the two molecules **A** and **B**. [1]

.....

.....

(b) Erwin Chargaff recognised that there were four types of bases in the nucleic acid found in the nucleus. The table below shows the results of his experimental work.

Source of nuclear material	*% adenine*	*% guanine*	*% cytosine*	*% thymine*
wheat	27.3	22.7	22.8	27.1
broad bean	29.7	20.6	20.1	29.6
salmon	29.7	20.8	20.4	29.1
bull	28.6	22.2	22.0	27.2
human	30.9	19.9	19.8	29.4

Source: Chargaff, E. (et al.) 1953, *Nature*, London, no. 172, p.289

(i) What conclusions did Chargaff draw from this data about the pairing of bases in the nucleic acids of various species? [1]

.....

.....

(ii) Using the data from the table above, explain how he came to his conclusion. [1]

.....

.....

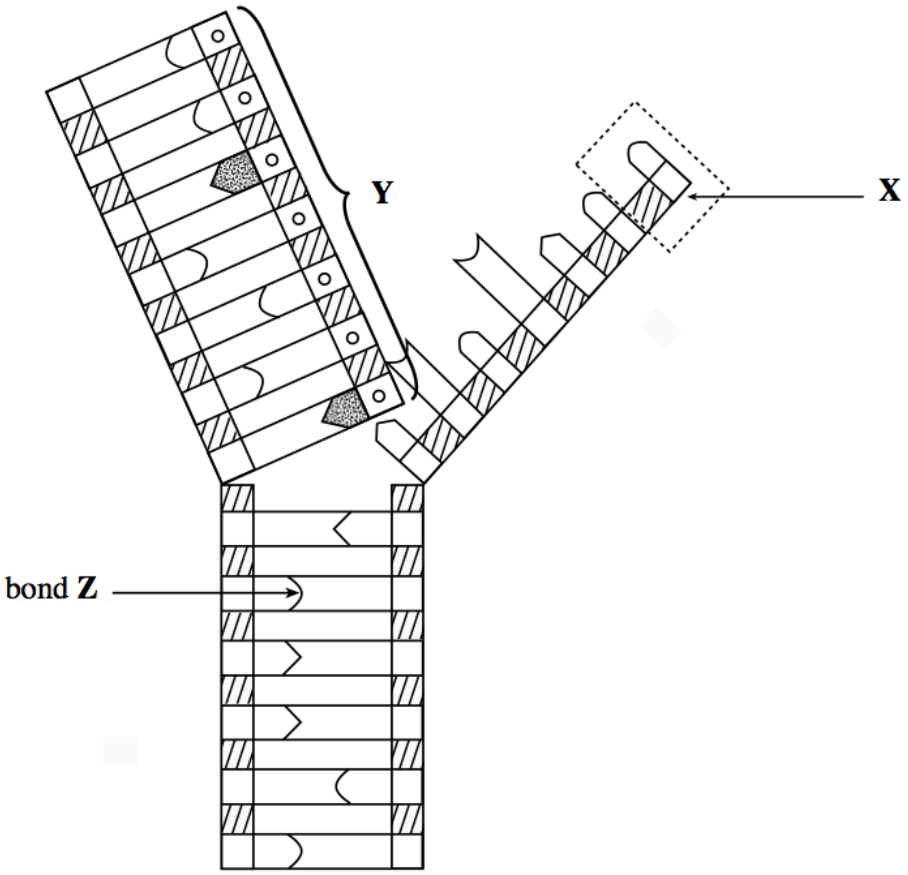
(iii) What category of bases are adenine and guanine? [1]

.....

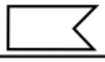
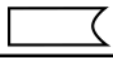
(Total 8 marks)

10.

The following diagram represents part of a DNA molecule and a mRNA molecule.



(a) The key for the diagram is shown below, as a table. Complete the table. [4]

Symbol	*Name of molecule*
	Deoxyribose
	Phosphoric acid
	Ribose
Pyrimidine base 	Uracil
Pyrimidine base 	
Pyrimidine base 	
Purine base 	
Purine base 	

(14)

(b) (i) Name the subunit labelled **X**. [1]

.....

(ii) Give the names of the component molecules which make up this structure. [3]

.....

.....

.....

(c) Name bond **Z** as shown on the diagram. [1]

.....

(d) Condensation reactions are involved in the production of DNA. Give the name of **one pair** of molecules which are linked in such a way. [1]

.....

(e) Give **two** pieces of evidence from the diagram which indicate that the molecule Y is RNA and not half a strand of DNA. [2]

1 .....

.....

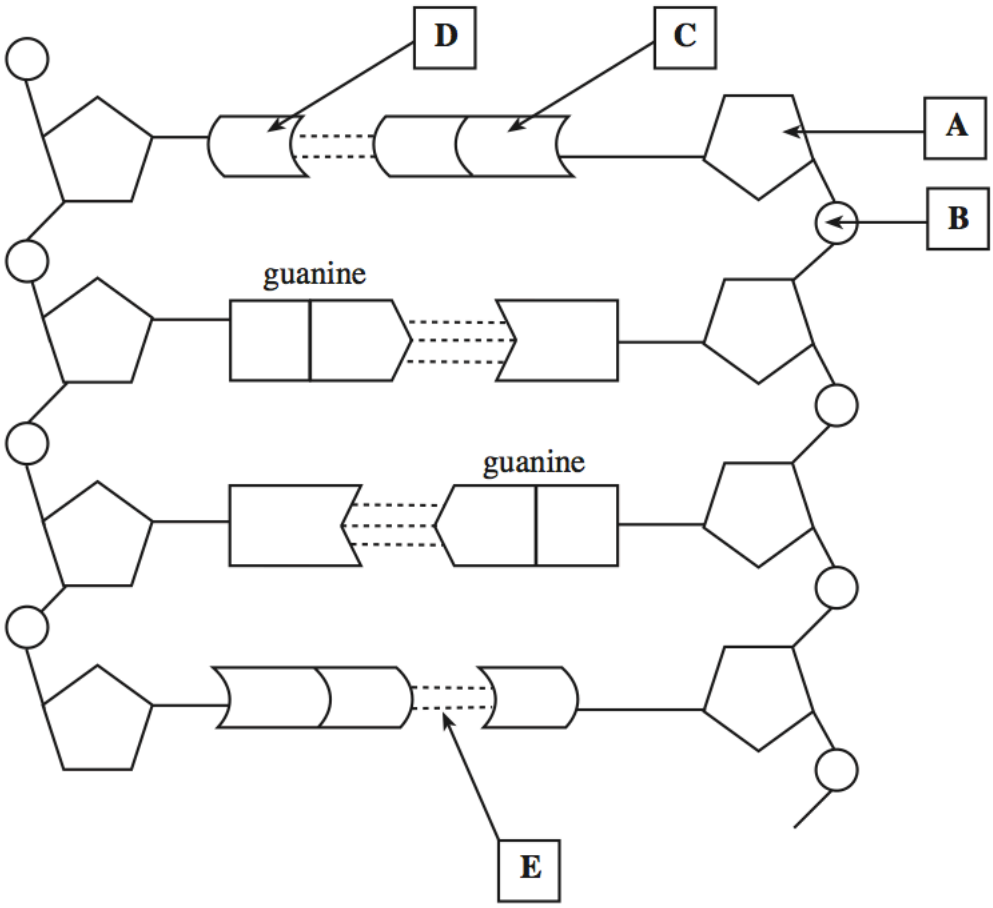
2 .....

.....

(Total 12 marks)

11.

The diagram below shows a section of a DNA molecule.



(a) Name the parts labelled **A** and **B**. [2]

A .....

B .....

(b) What type of bonding is shown at **E**? [1]

.....

(c) (i) What type of nitrogenous base is guanine? [1]

.....

(ii) Name the bases **C** and **D.** [2]

C .....

D .....

(d) **On the diagram above,** draw a ring around a single nucleotide unit. [1]

(e) A large sample of DNA was analysed and found to contain 28% of the nitrogenous base guanine. Calculate the percentage of the molecule that would be thymine.
You must show your working. [3]

.....

.....

.....

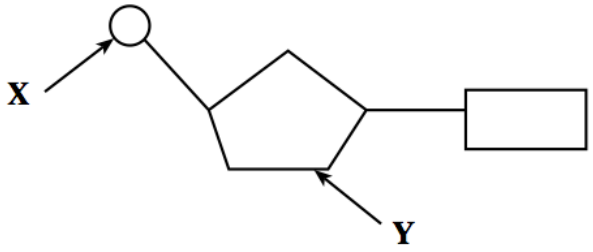
.....

.....

(Total 10 marks)

12.

(a) The diagram shows the structure of a DNA nucleotide.



Identify the parts of the nucleotide labelled **X** and **Y**. [2]

X .....

Y .....

(b) The table shows the percentage composition of bases in DNA of cattle and octopus.

Organism	*Percentage composition*			
	Adenine	*Cytosine*	*Guanine*	*Thymine*
cattle	29		21	
octopus	33			33

(i) Calculate the missing values and complete the table. [2]

(ii) Explain how you used your knowledge of the structure of DNA to arrive at your answer in (i). [2]

.....

.....

.....

.....

.....

(c) Describe **two** differences between the structure of DNA and RNA. [2]

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.....

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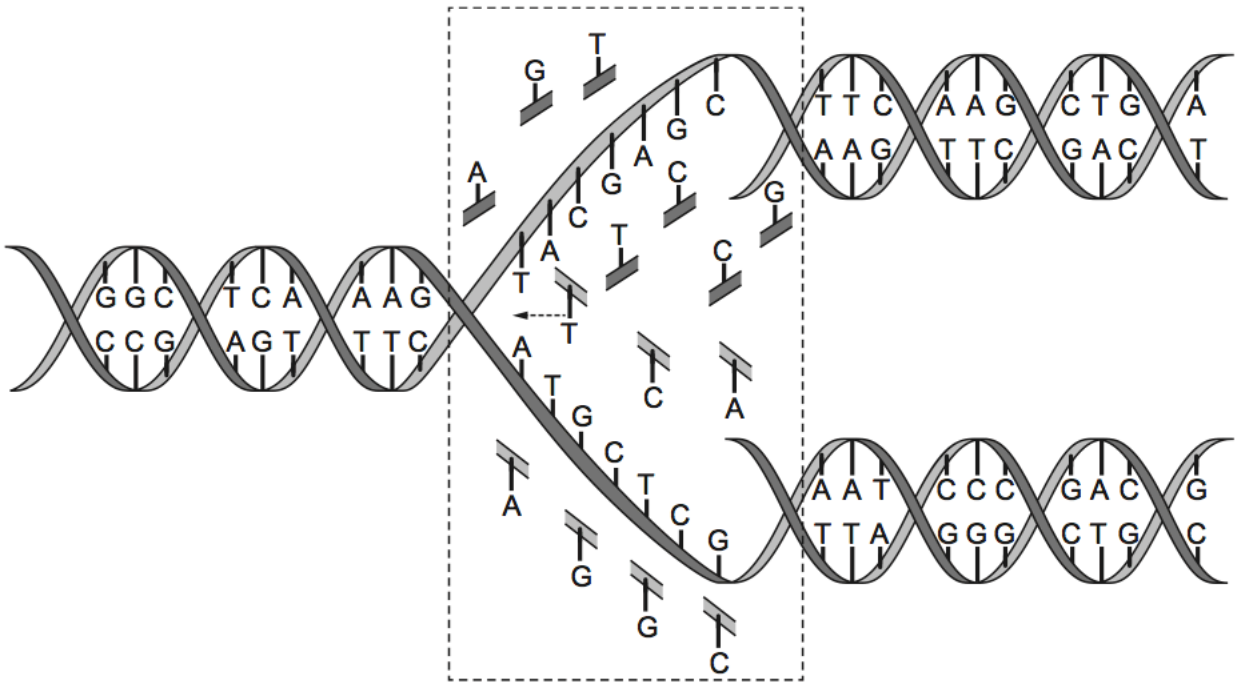
.....

13.

The diagram below illustrates replication of DNA in cells.



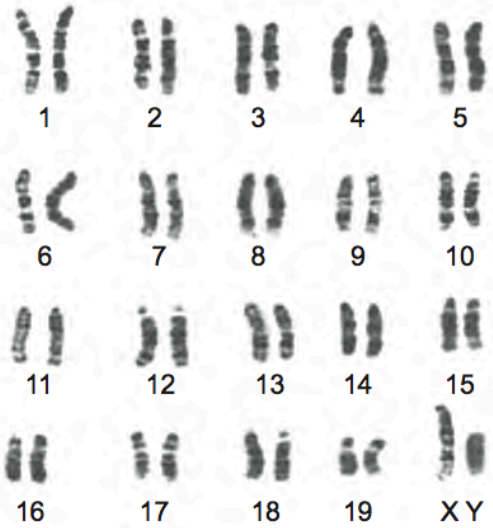
(a) (i) Describe the sequence of events shown within the dotted rectangle in the diagram above. [3]

(ii) What is the role of DNA polymerase in the process? [1]

(b) Explain why the process is referred to as 'semi conservative'. [2]

14.

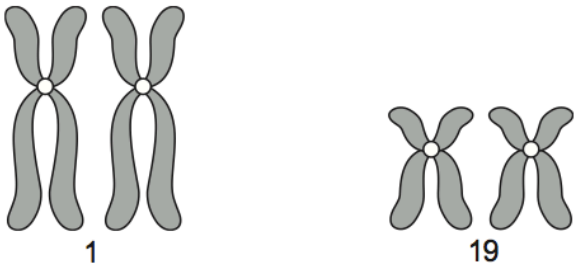
The photograph below shows the pairs of chromosomes found in a body cell of a mouse.



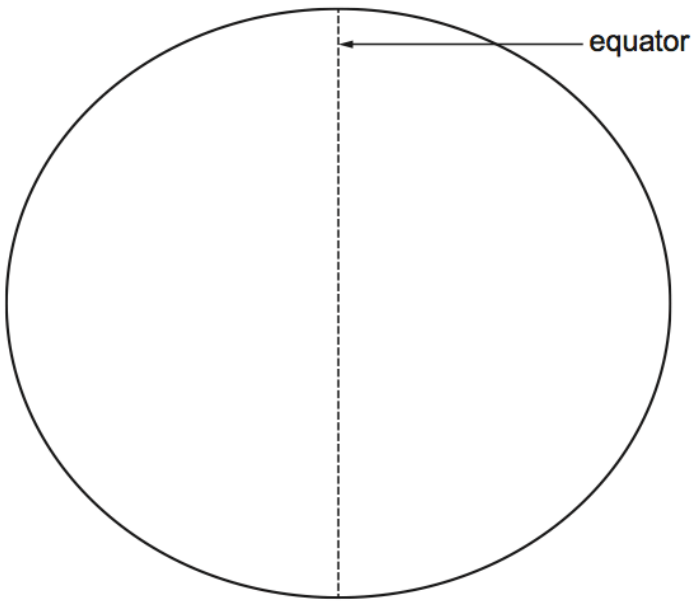
(a) What is the diploid number of the mouse? [1]

.....

(b) The chromosomes in pairs 1 and 19 are commonly represented diagrammatically as:

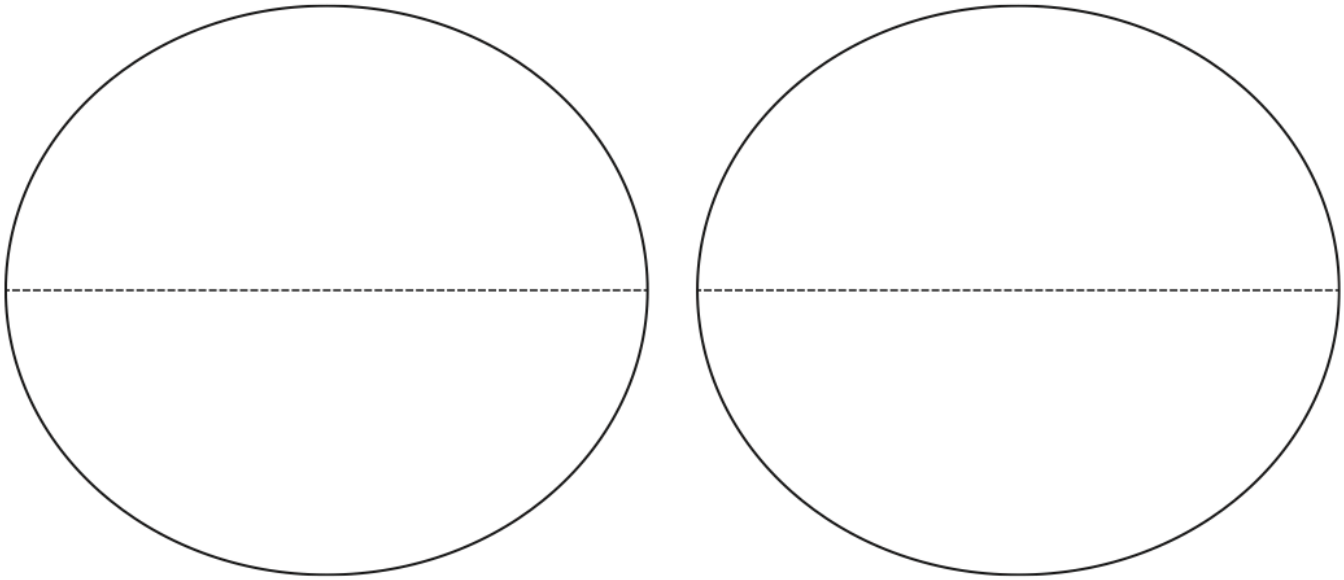


(i) Using the cell outline below draw diagrams to show how these pairs of chromosomes are arranged in **metaphase I** of meiosis. [1]



(ii) On your drawing label; chromatid, centromere, centriole, spindle fibres. [2]

(iii) Using the cell outlines below draw diagrams to show how the chromosomes would subsequently be arranged in **metaphase II** of meiosis. [1]



(iv) State **three** ways in which meiosis contributes to variation in mouse offspring. [3]

.....

.....

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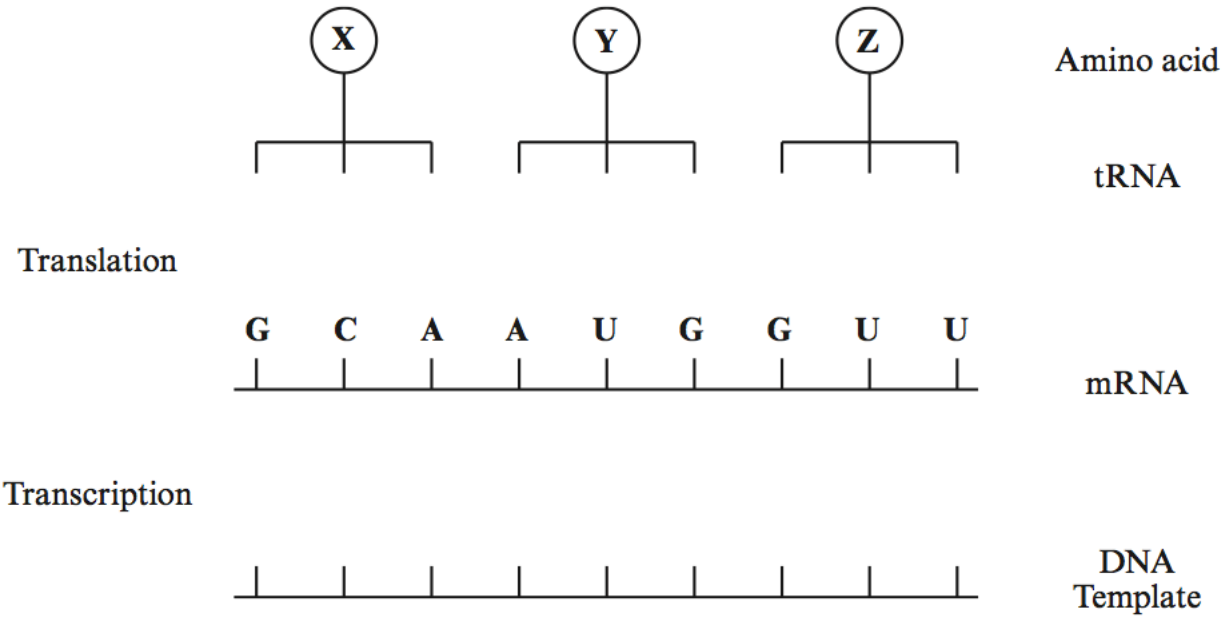
.....

15.

(a) Name the enzyme involved in the transcription stage of protein synthesis. [1]

.....

(b) The diagram shows some molecules involved in protein synthesis.



Complete the diagram to show

(i) the bases on the template DNA strand from which the mRNA was transcribed; [1]

(ii) the bases forming the anticodons of the tRNA molecules. [1]

(c) The diagram below shows the effects of two different mutations of the DNA on the base sequence of the mRNA.
The table shows the mRNA codons for three amino acids.

Original mRNA G C A A U G G U U

Mutation 1 G C U A U G G U U

Mutation 2 G C A A U G G C U

Amino acid	mRNA codon
methionine	AUG
valine	GUC GUU
alanine	GCA GCC GCU

Use the information in the table to

(i) Identify amino acid **X** in the diagram in part *(b)*. [1]

.....

(ii) Explain how each mutation may affect the polypeptide for which this section of DNA is part of the code.

Mutation 1 [2]

.....

.....

.....

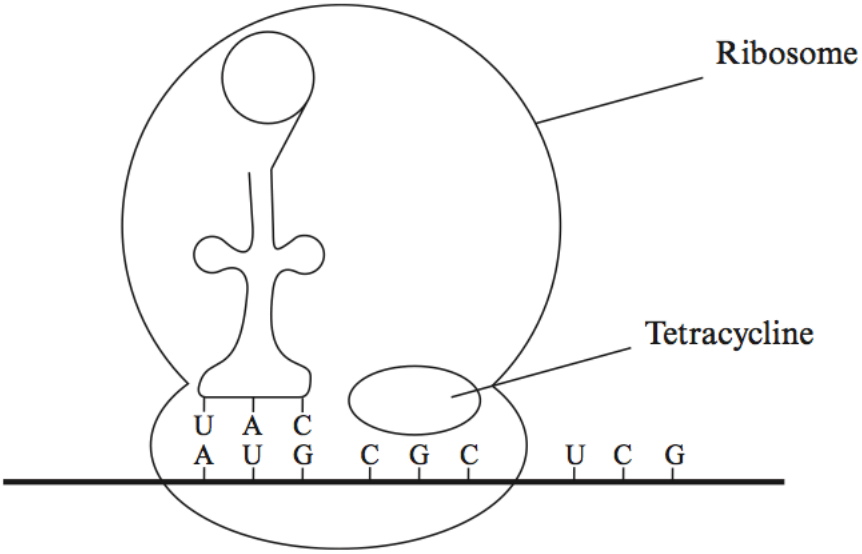
Mutation 2 [2]

.....

.....

.....

(d) Tetracycline is an antibiotic. The diagram below shows how tetracycline binds to bacterial ribosomes.



Explain how the tetracycline stops protein synthesis in bacteria. [3]

.....

.....

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.....

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.....

(Total 11 marks)

16.

Meselson and Stahl investigated whether DNA replicated in a conservative or semiconservative way.

(a) What is meant by the term semiconservative replication? [2]

.....

.....

.....

(b) The bacterium *Escherichia coli* (E.coli) was cultured in a nutrient broth, containing the heavy isotope as a source of nitrogen ^{15}N instead of the normal ^{14}N. After several generations all of the DNA in all of the bacteria contained the heavy isotope ^{15}N. They were then washed and transferred to a ^{14}N medium and allowed to replicate. After each generation, bacteria were removed and ruptured to release the DNA. The DNA was then placed in a medium and spun in a centrifuge. The position of the DNA in the medium was then determined.

(i) Name the part of the DNA molecule which contained the ^{15}N. [1]

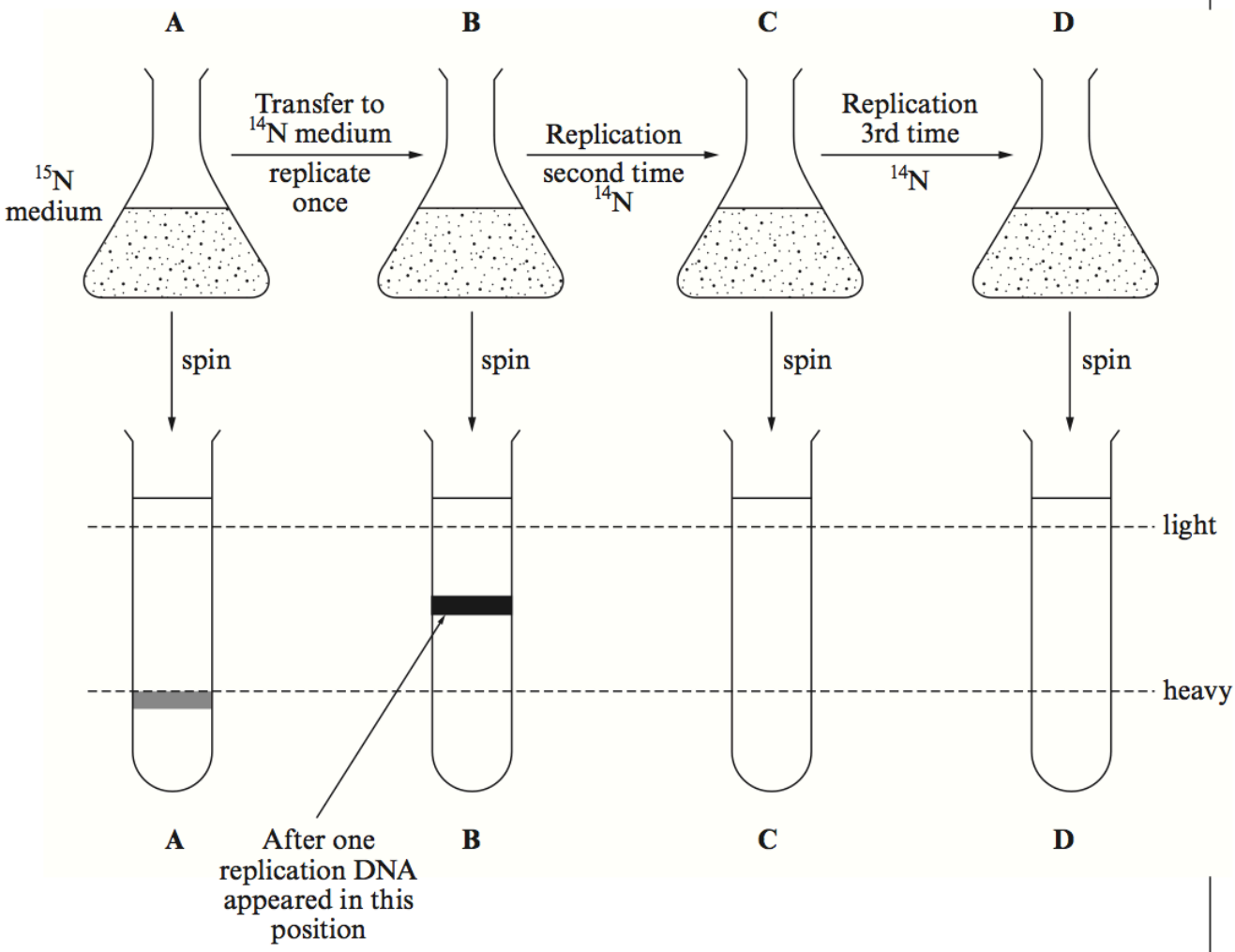
.....

(ii) If they wanted to show the relative position of DNA from different samples of bacteria, suggest **two** variables which would need to be controlled in the centrifugation process. [2]

1. .....

2. .....

(c) The diagram represents the results which they obtained.



(i) Explain why the results in tubes **A** and **B** support semiconservative replication. [3]

.....

.....

.....

.....

.....

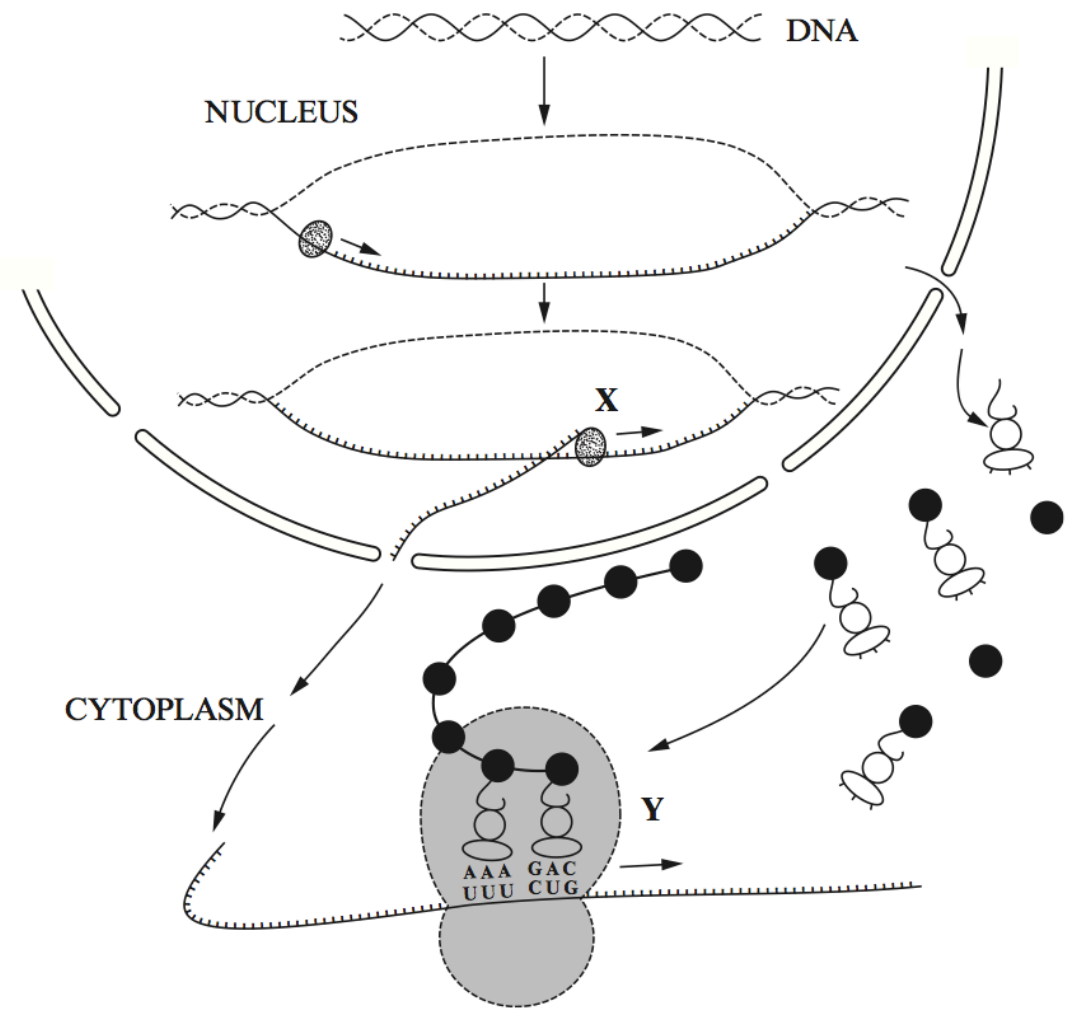
.....

(ii) Complete diagrams **C** and **D** to show the pattern and relative proportions of DNA you would expect. [2]

(Total 10 marks)

17.

The diagram represents stages of protein synthesis.



(a) (i) Give the name of the processes taking place at **X** and **Y**. [2]

X .....

Y .....

(ii) On the diagram label the following structures using clear lines and the letters given. [8]

M = messenger RNA
N = nuclear pore
O = RNA polymerase
P = codon
Q = ribosome
R = transfer RNA
S = three hydrogen bonds between complementary bases
T = template/sense strand of DNA

(b) Transfer RNA (tRNA) molecules are very specific and will only carry one type of amino acid depending on three unpaired nitrogenous bases on the molecule (the anticodon). The table shows the type of tRNA molecules which combine with certain amino acids.

Amino acid	*anticodon*
glycine	CCU
cysteine	ACA
arginine	GCA
alanine	CGU

Using the information given, state the nucleotide sequence on the **DNA molecule** which codes for the following polypeptide. [2]

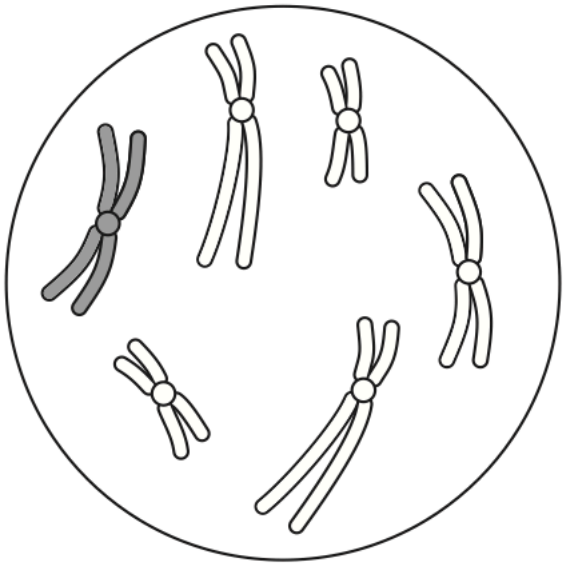
glycine-cysteine-arginine-alanine.

.....

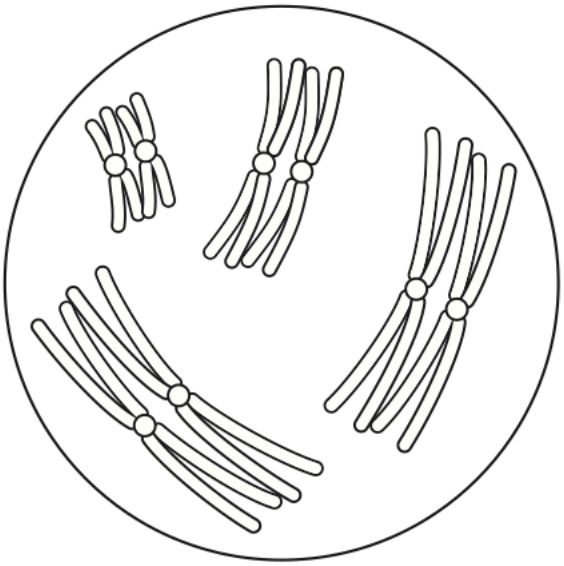
(Total 12 marks)

18.

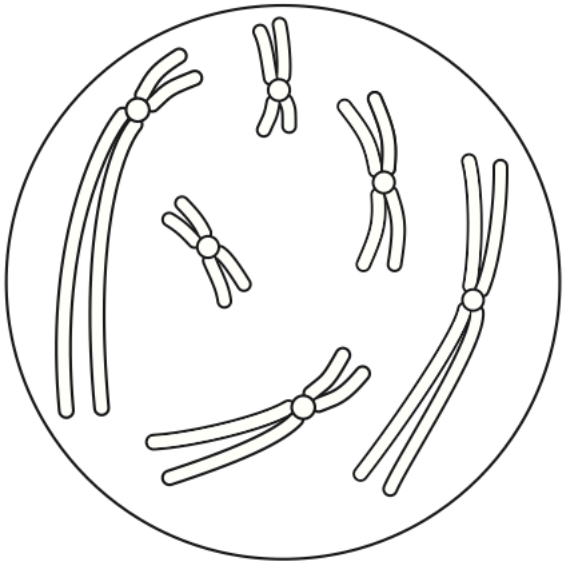
The following diagrams, **A** to **D** are of nuclei undergoing mitosis or meiosis.



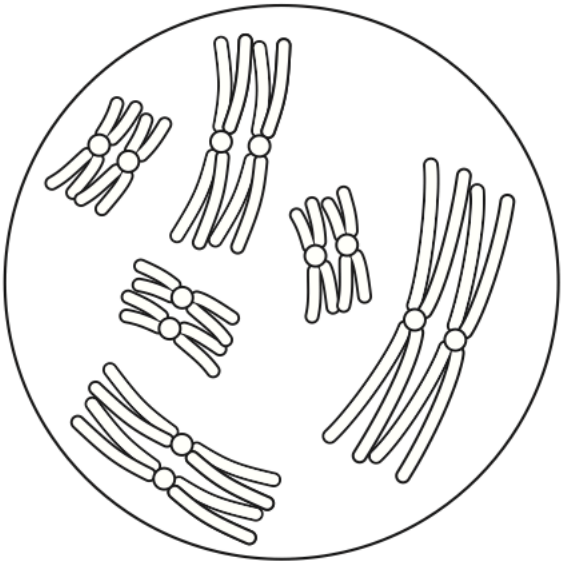
A



B



C



D

(a) On diagram **A** one chromosome has been shaded. Shade the homologous chromosome. [1]

(b) Which of the diagrams **A-D** show cells undergoing prophase 1 of meiosis. [1]

.....

(c) The diploid number of chromosomes in a mosquito *(Culex sp.)* is 6 (2n 6) and in a kangaroo *(Macropus sp.)*12 (2n 12).
State which of the diagrams, A, B, C or D represents the following: [2]

Haploid cell from a kangaroo .....

Diploid cell from a mosquito .....

(d) (i) A species of ant *(Myrmecia pilosula)* has a diploid number 2. Why is it not possible to have an organism with a diploid number lower than this? [1]

.....

(ii) In this species of ant the male is haploid, suggest the type of cell division this organism would use to produce sperm cells. [1]

.....

(e) The following gives the names of some stages of cell division.

Anaphase 1	Metaphase 2	Anaphase 2	Prophase 1	Telophase 2	Metaphase 1
M	N	P	Q	R	S

(i) Using only the letters, give the correct sequence of the stages. [1]

.....

(ii) State the **letter** of the stage when each of the following processes occur. [5]

Pairing of chromosomes .....

Centromeres divide .....

Crossing over .....

Bivalents align on equator .....

Nuclear membrane reforms .....

(Total 12 marks)

19.

(a) Part of a particular sequence of bases on a DNA molecule is as follows:

T T A T C T T T C G G G A T G

(i) Give the sequence of nitrogenous bases on the mRNA which is obtained by using this DNA molecule as a template. [1]

.....

.....

mRNA codons	*Amino acid*
AAG	Lysine (lys)
AAU ACA AGA AUA	Asparagine (asn) Threonine (thr) Arginine (arg) Isoleucine (ile)
CAU CGG CGU	Histidine (his) Arginine (arg) Arginine (arg)
CCC CCG	Proline (pro) Proline (pro)
CUU	Leucine (leu)
GAU GAA GAG GCA	Aspartic acid (asp) Glutamic acid (glu) Glutamic acid Alanine (ala)

mRNA codons	*Amino acid*
GGA	Glycine (gly)
UAU	Tyrosine (tyr)
UGC	Cysteine (cys)
UCG	Serine (ser)
UUG	Leucine (leu)
UCU	Serine (ser)
UGG	Tryptophan (trp)
UUA	Leucine (leu)
UAC	Tyrosine (tyr)

(ii) A sequence of nitrogenous bases on another section of mRNA is shown below.

UACAGAGCAUCGUUA

Using the table, determine the order the amino acids would be incorporated into the polypeptide constructed from this mRNA sequence (the abreviations of the amino acids in brackets can be used). You may assume that the sequence is read from the left hand end. [1]

.....

.....

(iii) Suggest how the cell ensures that the code is read in the correct direction. [1]

.....

.....

(iv) Proflavin, is a chemical which alters the base sequence of DNA. What is the name given to such a change ? [1]

.....

(v) If proflavin caused the deletion of the first adenine, (A), in the DNA sequence which codes for the above mRNA, what consequences would this have on the subsequent translation of the sequence? [1]

.....

.....

(b) Haemoglobin is a protein found in red blood cells.
Haemoglobin is a quaternary protein.
There are three different types of haemoglobin found in adult humans, HbA, HbA_2 and HbF as shown in the table.

Haemoglobin type	*% found in adult*	*Types of polypeptide*
HbA	97	2 alpha chains 2 beta chains
HbA_2	2	2 alpha chains 2 delta chains
HbF	1	2 alpha chains 2 gamma chains

(i) From **this data** suggest how many genes are involved in the production of the haemoglobins found in the adult human. [1]

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(ii) Beta thalassaemia is a condition in humans caused by a change in the nucleotide sequence which codes for the primary structure of the beta polypeptide chain. Scientists have now discovered a drug which can switch on the gene for the production of HbF (HbF is the type of haemoglobin found in the fetus). Explain, using your knowledge of protein synthesis, how this drug results in the production of HbF. [4]

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(iii) Give **one** disadvantage in an adult human of not producing beta chains of haemoglobin. [1]

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(iv) Give **one** possible disadvantage if an adult has fetal haemoglobin. [1]

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(Total 12 marks)

(1075-01)

Essays

1.

(b) Give an account of the structure and function of nucleic acids. [10]

2.

(b) Describe the structure of DNA. [10]

3.

(b) Describe the similarities and differences in the structure of amino acids and nucleotides. [10]

4.

(a) (i) Describe the structure of DNA. [7]
(ii) What are the differences between DNA and RNA? [3]

5.

(a) Describe how a nucleotide sequence on a DNA molecule results in the production of a polypeptide.